THE PRESERVATIVE TREATMENT OF FENCE POSTS AND OTHER STRUCTURAL MATERIALS

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The purpose of this report is to present in concise form the important factors which must be taken into account in the preservation of wood to increase its serviceable life when used under conditions favoring deterioration by decay and insects.

The preservation of wood to increase its durability may be accomplished in many ways and for the benefit of those who wish to study the subject more thoroughly a list of references is appended. This bulletin covers a limited number of methods and preservatives which have been tested at this Station or by other public agencies. It is confined chiefly to simple methods and to preservatives that can be used easily and safely without expensive equipment. The failure to mention any method or preservative should not be construed as disapproval of such method or preservative.

While the information has been prepared for Connecticut conditions, much of it is applicable throughout northeastern United States. It deals primarily with the preservation of fence posts and poles but also includes some suggestions for other structural timbers and the use of commercially treated wood under certain conditions.

In presenting the following material, the authors claim no credit for originating the methods described. They have drawn freely on existing literature and on their own experience in the application of some of these methods on a fairly large scale. Their statements cover only those methods and preservatives that they feel can be successfully used by the small operator under local conditions.

CAUSES OF DETERIORATION

Deterioration of wood, other than that due to breakage and mechanical wear, may be caused by several species of wood-rotting fungi and by insects. Of these, fungi are by far the most important in this region.

It is generally true that a preservative treatment, which will prevent decay, will usually offer adequate protection against insect attack. However, some insects present special problems; these should be taken to an entomologist for diagnosis and recommendations for control. For the purpose of this report, the control of insect attacks on wood will be considered as incidental to the more important problem of protecting wood against decay.

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1 The authors wish to express their appreciation to:

1. Dr. George A. Garratt, Dean, School of Forestry, Yale University, for advice on many phases of the experimental work and for reviewing the text of this bulletin.

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3. The authors of the several texts cited in the bibliography whose ideas have been so freely used in the preparation of this paper.

CONDITIONS FAVORING DECAY

Wood-rotting fungi take their sustenance from the wood, eventually rendering it useless for structural purposes. To grow and function, these fungi must have favorable conditions of temperature and moisture. In addition, air must be present in adequate amounts. If air is excluded (as in water immersion), wood will not rot.

Wood is most apt to decay when it is in constant contact with the soil or with decaying organic matter. Such conditions are encountered when posts, poles or sills rest directly on, or are buried in, the ground. Less severe conditions are to be found in the case of barn sills, floors and baseboards resting on concrete which may "sweat" at certain seasons. Greenhouse flats and benches and certain types of stakes which are used intermittently but are dried out during periods of non-use are also examples of conditions moderately favorable to decay.

DEGREE OF PROTECTION NEEDED

From the preceding section, it is obvious that the type of preservative treatment should be in accordance with the conditions under which the wood is used. For posts, poles and other timbers which are permanently in contact with the soil, conditions favoring decay are most severe and treatment should be the best that can be given. On the other hand, timbers which are used under conditions less favorable to decay, especially those which can be retreated periodically, may often be adequately protected by much simpler and less expensive methods.

POINTS TO REMEMBER

The 12 points itemized below are set forth as a general guide to the person who expects to treat his own timber. While they refer specifically to the treatment of posts and poles, much of the information is applicable to treatment of other kinds of timbers, used under conditions which make them susceptible to decay.

1. The only practical way to prevent decay is to introduce into the wood some chemical which is poisonous or inhibitory to fungi.

2. The aim of preservative treatment is to provide an evenly treated zone of wood *extending inward from all exterior surfaces* of a timber to such depth that the zone will not be easily ruptured nor the preservative quickly leached out.

For oily or oil-soluble preservatives, the treated zone on posts and poles should be at least one-fourth inch and, for water soluble preservatives, at least one inch in depth. This necessitates an impregnation treatment as described later under "Impregnation Methods".

Surface treatments by brushing or spraying with, or by brief immersion in, a preservative are not recommended for posts and poles although they may be used satisfactorily on other structural timbers as will be shown later.

3. The top ends of all posts should be cut slanting (roofed) to shed water and all boring, framing and other cutting operations should be performed *before the post is treated.*

4. *Only sound wood* should be treated. Posts which must be seasoned before treatment, if cut between March 15 and October 15, should be peeled immediately after cutting to prevent decay and insects from causing deterioration beneath the bark. Posts cut between October 15 and March 15 should be peeled before May 1.

5. With few exceptions, *sapwood* can be *much more easily and uniformly treated* than *heartwood.* Therefore always use round, in preference to sawed or split posts. If both sapwood and heartwood are exposed, the former will absorb most of the preservative and the latter will be impregnated to a very shallow depth.

6. Different kinds of wood vary greatly in the ease with which they may be treated by any given method or preservative. The combinations of wood, method of treatment and preservative, as outlined below, are those which experience has demonstrated to be most consistently successful under local conditions.

7. The *sapwood* of all native species *decays more readily* than the *heartwood.* White oak, red cedar, white cedar and locust are the only woods found in Connecticut in some abundance, the heartwood of which, without treatment, has a serviceable life in contact with the soil equal to or greater than chestnut, i.e., 10 years or more. The *sapwood* of these species is *not durable.* Therefore, when procuring posts of these species for use untreated, specify a round post with sapwood ½ inch or less in thickness or a squared post from which the sapwood has been removed by sawing.

The *untreated heartwood* of practically all other species found growing in the state will become unserviceable in contact with the soil in from two to five years. By suitable preservative treatment they can be made to last as long or longer than chestnut.

8. Posts of native species, other than white oak, red cedar, white cedar and locust, should be treated throughout their entire length. If the tops are not treated they may be expected to decay in six to ten years.

9. The minimum sized post that will satisfy the requirements of the job should be used.

10. It is advisable to buy preservatives according to specification and to avoid preservatives for which the manufacturer is unwilling to submit specifications or which are excessively high in price.

The preservatives which have been thoroughly tested are relatively few in number and their properties are well known. The operator would do well to confine himself to them rather than to experiment with untried materials which may have little value or which may be unduly expensive. The cost of preservative per cubic foot of wood treated should be 20 cents or less.

11. Very appreciable savings in the cost of preservatives can be made by buying in quantity. In small lots the unit cost is usually several times that in larger lots. To effect these savings, the purchaser should ascertain the unit price in varying quantities up to carload lots and then buy the largest quantity commensurate with his needs.

12. There is no *royal road* to preservative treatment. The impregnation of wood with any material is not easily accomplished under the most favorable conditions but, if the operator approaches the problem intelligently, he can be assured of results that will more than offset the costs incurred.

PRESERVATIVES

All wood preservatives may be divided into two groups: (a) those which are of an oily nature, or are soluble in oil, but insoluble in water, and (b) those which are soluble in water.

Oily or Oil-Soluble

Coal tar creosote is the best known and most thoroughly tested preservative in this group. It is an oily liquid and is ready for use in the form in which it is received. Creosote for use in Open-tank Treatments should conform to A. W. P. A.[1] specifications for Grade 1, Coal Tar Creosote. Coal tar creosote, conforming to A. W. P. A. specifications for Brushing or Spraying Treatment, should be used when the preservative is applied by brush or spray gun, or by brief immersion.

Many oils and tars are sold as creosote, often at a very low price. These may or may not be toxic to fungi. To protect himself, the purchaser should make sure that they are derived from coal tar and conform to specifications of the American Wood Preservers Association.

Caution: Creosote can cause severe burns on tender skin and care should be taken to keep it away from the eyes and from under cuffs and glove wristlets. It is also injurious to plant tissue and should not be used on the tops of stakes or posts where tender plant growth will come in contact with it. Neither should it be used above ground in the interior of such structures as tobacco shade tents, greenhouses and hot beds, since fumes from it may injure plant growth without direct contact. It is also inadvisable to use creosote where very young animals or birds will come directly in contact with it before it has dried thoroughly into the wood. Older animals and birds do not appear to be affected by it.

No attempt should be made to apply paint to creosoted wood because, unless the preservative is thoroughly covered with some impenetrable coating such as shellac, it will "strike through" the paint and render it unsightly.

Pentachlorphenol is a comparatively new oil-soluble preservative which shows much promise. In its natural form it is a dry, flaky powder which may

1 American Wood Preservers Association

cause irritation to the mucous membranes. For this reason the purchaser is advised to obtain it as a concentrated liquid solution which is diluted to required strength by adding kerosene, fuel oil, Stoddard solvent or old crank case oil. The last named will leave an oily surface on the wood which may be undesirable for some purposes.

Copper napthenate has recently come into use as a wood preservative. This material is also oil-soluble and, when dissolved in a suitable petroleum solvent, appears to have excellent fungicidal properties. The literature on it is as yet rather meager.

Pentachlorphenol and copper napthenate, after drying, leave the wood with a clean paintable surface, provided the solvent is reasonably volatile.

Water-Soluble

Zinc chloride, sodium fluoride, copper sulfate and mercuric chloride are the best known water-soluble preservatives. They are all poisonous to fungi. Since they are soluble in water, they must penetrate the wood to a considerable depth. Otherwise, they will soon be leached out by the soil water. Mercuric chloride and sodium fluoride are quite poisonous to man and animals and must be handled with great care. Mercuric chloride and copper sulfate are very corrosive to iron or steel. Zinc chloride is considered to possess most of the advantages of the other preservatives mentioned. It is quite safe to handle and only slightly corrosive. Chromated-zinc chloride may also be used but is somewhat higher in price than straight zinc chloride. The granular form is preferable. Zinc chloride should be acid free, contain 94 per cent or more of zinc chloride and not more than 0.1 per cent of iron. Chromated-zinc chloride should contain not less than 17½ per cent sodium dichromate dihydrate and not less than 77½ per cent zinc chloride.

Wood, which has been treated with water soluble salts and later seasoned, presents a clean paintable surface.

Both zinc chloride and chromated-zinc chloride in granular form absorb moisture readily from the air and, if they are to be kept in dry form, the container must be tightly sealed. The operator may find it to his advantage to store them as 50 per cent solutions in an open metal drum. To make such a solution, add one pound (one pint) of water to each pound of salt and mix thoroughly.

PRESERVATIVE METHODS

All preservative methods may be classified as follows:

A. Impregnation Methods. The objective of all impregnation methods is to force or transport the preservative into the wood to such a depth in all directions from the surface that the untreated interior of the timber will be

protected by a heavily treated shell which is not easily broken. This may be accomplished by one of the following methods:

1. Artificial pressure
2. Open-tank
3. Displacement or sap stream
4. Steeping or cold-soaking

B. Superficial Methods. These consist in brushing or spraying the wood with, or briefly immersing it in, an oily or oil-soluble preservative. There is virtually no penetration of the preservative into the wood.

Impregnation Methods

Artificial Pressure

Treatment is accomplished by placing the timbers in a closed cylinder, into which the preservative is introduced at high pressure and high temperature. A preliminary and/or final vacuum may or may not be used. This method requires heavy and expensive equipment and will not be used by the small operator.

Preservatives are forced very deeply into wood by this method and timbers so treated may be expected to have an extremely long life. The home owner will probably not use pressure-treated posts because of the high initial cost. He would do well, however, to specify pressure-treated lumber at critical locations on new construction. Such locations are sills, porches, bathroom baseboards and wood floors laid over concrete, in fact, any location where air drainage is poor and moisture may be present from condensation or other causes.

If creosote is not objectionable, it is unquestionably the best preservative. However, where a clean, paintable, non-odorous timber is required, wood pressure-treated with a water-soluble preservative such as Wolman salts or chromated-zinc chloride or with pentachlorphenol or copper napthenate dissolved in a light solvent will give very satisfactory results.

Open Tank

This method is based on the principle that, if wood is immersed in the preservative liquid for several hours at an elevated temperature, some of the air and water contained in the outer layers will be driven off. The subsequent cooling of the air and water remaining in the outer layers, as the result of contact with the cooler preservative, creates a partial vacuum into which the preservative is forced by atmospheric pressure on the surface of the liquid.

This is a very old method which has been extensively used for many years by both commercial operators and individuals for the treatment of the butts of posts and poles with creosote and other preservatives. The operation, as usually described for creosote [1], consists of immersing the butts of the

1. Coal tar creosote is the only preservative used by this Station with the open-tank method and the statements given below are for this preservative only. Other preservatives may be applied in the same manner but some details of the operation must be modified. If the reader uses other preservatives, he is advised to secure specific recommendations regarding their application.

timbers for several hours in preservative which is maintained at a temperature of 215° to 220° F. and then either allowing them to stand in the same preservative as it cools off or transferring them to another tank in which the preservative is kept at about 100° F.

Experience at this Station in the treating and subsequent inspection of some 75,000 open-tank creosoted posts indicates that the process should be modified to the extent of using a tank that will accommodate the timber in a horizontal position. This will provide for a full-length impregnation treatment of the post and avoid the possibility of early decay of the top after the post is placed in service. Experiments in treating many kinds of wood also indicated that very few of the forty or more kinds of locally grown woods can be easily treated.

The equipment needed for a small to medium-sized operation consists of:

a. A metal tank four feet wide, five feet deep and one foot longer than the timber to be treated. This tank must be provided with a means of heating the preservative. This may be done indirectly by circulating steam through coils located in the bottom of the tank. This is the safest but also the most expensive method. Heat may be applied directly by mounting the tank on a brick or stone foundation which, when provided with a stoking door and a chimney, serves as a fire box. Wood may be used as fuel. This is a simple method which is easily accomplished. However, great care should be taken that creosote does not come in contact with an open flame.

A better method of applying direct heat is to install a return bend in each end of the tank as shown in Figure 1. A wood fire maintained under the bend will cause a circulation of the preservative and maintenance of the desired temperature. The fires under the bends can be shielded to keep flame away from the tank.

b. A thermometer reading to 240° F.
c. A simple hoist to handle the posts.
d. A weighting device to keep the posts from floating.

The preservative recommended is Grade I, A. W. P. A. Coal Tar Creosote.

The wood should be carefully peeled to remove all outer and inner bark and should be thoroughly air seasoned. It should also be free of surface moisture when treated.

Woods suitable for posts and small poles are oak (all species), native pitch or yellow pine, red pine and Scotch pine.

The duration of the hot bath, maintained at 215° to 220° F., should be six hours for oak posts and four hours for pine posts. The duration of the cooling or cold bath should be about half that of the hot bath but not less than two hours.

These bath periods should be used as a guide. Under some conditions, it may be desirable to lengthen or shorten the time. The goal sought is an absorption of four to eight pounds of creosote per cubic foot of wood treated

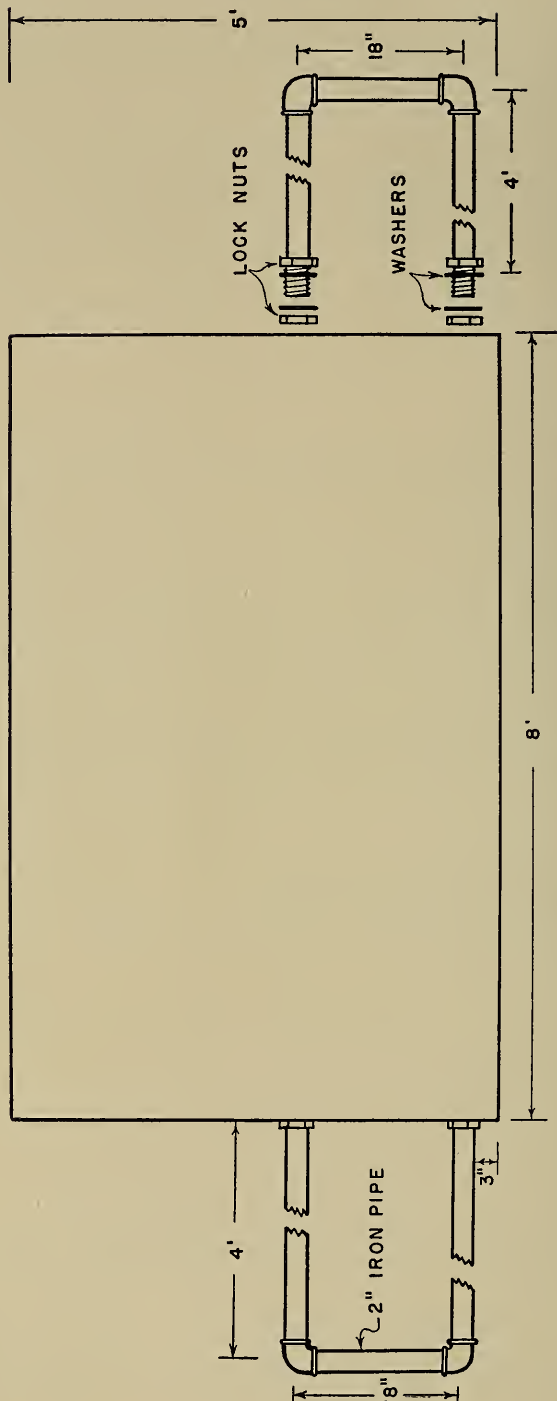

Figure 1. Side view of tank and pipe connections.

(see Table 2) and a penetration depth of at least ¼ inch at the mid-point of the post. Absorption may be checked by weighing a post or two in each charge before and after treatment; penetration, by boring a hole with a ½ inch bit at the mid-point. After inspection, this hole should be filled with creosote and closed with a creosoted wood plug or with roofing plastic.

Sawed lumber may be given a full length treatment by the open-tank method if stickers (small strips of wood) are placed between the pieces to permit circulation of preservative. If, however, this lumber contains both sapwood and heartwood, most of the preservative will enter the former. There will usually be very little penetration of the heartwood and, for this reason, the results may be little, if any, better than if the material were treated by "cold soaking" as described below.

Displacement or Sap Stream

As here used, the term "sap stream method" applies to several more or less related processes which introduce water-soluble chemicals in solution into the water-conducting tissues of the wood. Subsequent to its entry into the wood the chemical (preservative) usually diffuses to a considerable extent so that finally the sapwood is quite well penetrated. The heartwood is usually not penetrated appreciably.

At this point it may be well to emphasize that all the sap-stream methods *are applicable only to freshly cut unbarked wood;* they are not applicable to sawed lumber. In this report only those processes will be discussed which appear to have a practical bearing on the preservation of posts and poles.

Three modifications of the sap-stream method (tire-tube, stepping and barrel) are described below. They are based on the use of zinc chloride or chromated-zinc chloride as a preservative and each has as its objective the retention of 16 ounces of dry zinc chloride or 13 ounces of dry chromated-

TABLE 1. QUANTITIES OF SOLUTION NEEDED TO PROVIDE FOR AN APPROXIMATE RETENTION OF 16 OUNCES OF ZINC CHLORIDE OR 13 OUNCES OF CHROMATED-ZINC CHLORIDE FOR EACH CUBIC FOOT OF WOOD TREATED.

Strength of solution per cent	Number of pounds of solution needed for each cubic foot of wood treated	
	Zinc chloride	Chromated-zinc chloride
4		20
5	20	
6		14
7	14	
8		10
10	10	
20		4
25	4	
40		2
50	2	

zinc chloride by each cubic foot [1] of wood treated. The dry salt is dissolved in water to make a solution of the strength required.

Table 1 gives the number of pounds of solution of different strengths which must be used to provide for this retention.

Native woods suitable for treatment by sap-stream methods are all species of maple, birch and pine. Birch should not be treated during the winter. It is not advisable to mix species when treating by the barrel or stepping methods.

a. *Tire-tube Method.* The tire-tube method is applicable to posts and poles four to eight inches in diameter. The apparatus needed is shown in Figure 2 which is largely self-explanatory. The section of old tire tube, two to three feet long, is drawn over the butt end of the post and fastened securely to form a tight seal between the tube and the post. Usually some draw-shaving is necessary to provide a reasonably smooth surface free of abrupt depressions. Fastening the tube to the post may be done with rubber bands or wire. One very effective method is to wrap one turn of 12-gauge wire around the tube and post and draw up the ends with pliers. Two rubber bands cut from an old tire tube make a good cushion between wire and tube and also prevent injury to the latter. Tapping the wire with a hammer after it has been drawn taut will usually stop any small leaks that may occur. After the tube has been attached to the post, the latter is placed on the rack, as shown. The preservative solution is then poured into the tube, the open end of which is fastened to the rail above. The rack should be so constructed that the lower end of the post is at least 18 inches below the end to which the tube is attached.

Treatment is completed when all the liquid has been drained from the tube by gravity. The water normally found in green wood is forced out at the lower end of the post together with a small amount of the preservative solution. This drip should be collected, strained and used in mixing the next lot of solution.

The tire-tube method may be used at any time of the year when the temperature is above the freezing point. However, the preservative will be absorbed much more quickly in warm weather. The time needed will vary with the species, season, length of stick, *etc.*, but for material of fence post size, treatment will usually be completed in 4 to 24 hours. The technique involved is quite simple and can be carried out very easily after a little practice.

Posts may be set immediately after treatment but seasoning for a few weeks is advantageous. Peeling is unnecessary unless the post is to be painted, in which case only the part above ground need be peeled. If it is possible to do so, the posts should be cut to length before treating but, if it is necessary to do such cutting after setting, the cut should be painted over with creosote or a strong solution of zinc chloride.

The amount of preservative recommended *for each cubic foot of maple and birch treated* is 14 lbs. of 7 per cent zinc chloride solution or 14 lbs. of 6 per cent chromated-zinc chloride solution; *for each cubic foot of pine,* 20 lbs.

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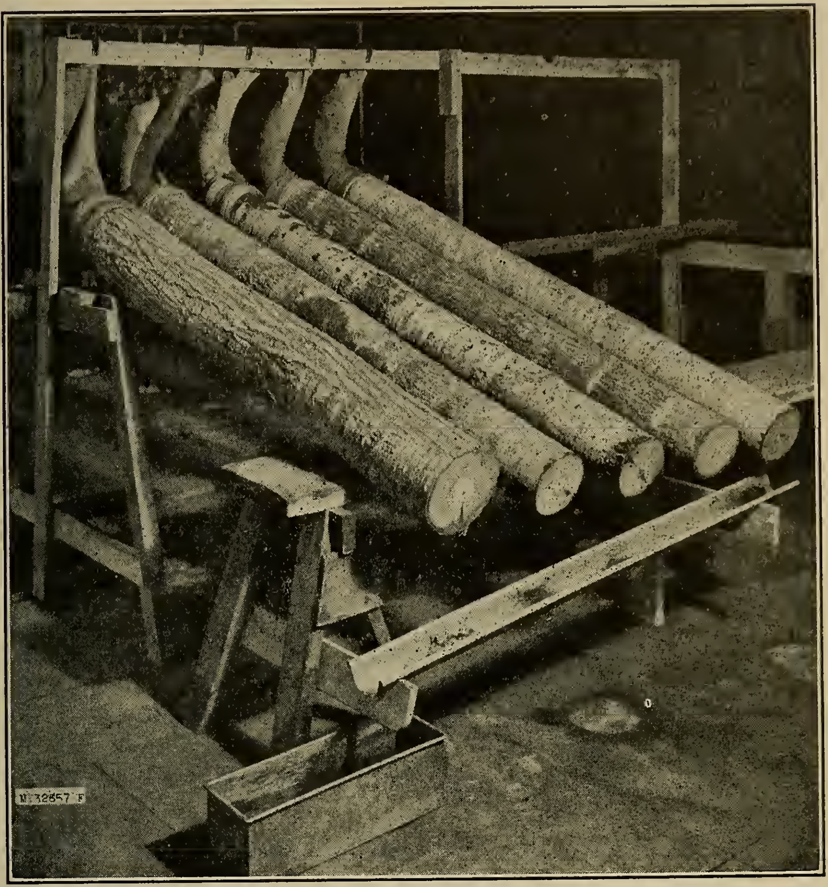
1 For measurement of wood volume, see Table 2.



Photograph courtesy of U. S. Forest Service

Figure 2. Equipment used in the tire tube method.

of 5 per cent zinc chloride solution or 20 lbs. of 4 per cent chromated-zinc chloride solution.

b. *Stepping Method.* Bean poles, stakes and similar small round material may be treated by the stepping method. When the trees are cut, *all or a considerable portion of the green crown* is left intact. The cut ends are immersed in a barrel containing the preservative solution which, through the action of the leaves, is drawn up through the sapwood in the same way that water is drawn from the soil and distributed in the living tree. The rapidity with which this takes place will depend on the activity of the foliage in transpiring moisture. The method may be used for evergreens (pine, spruce, etc.) throughout the year when temperatures are above freezing. Absorption will be most rapid during the summer and may cease altogether at low temperatures. Broad-leaved trees must be treated when in leaf.

The amount and strength of solution recommended for each cubic foot of wood treated is the same as for the tire-tube method. Only one kind of wood should be included in the same charge.

A modification of the stepping method, known as "capping", can be applied to poles up to six or eight inches in diameter by felling the tree, leaving the top intact and applying a tire tube filled with solution as in the tire-tube method described above.

c. *Barrel Method.* A considerable amount of work has been done by this Station on this method which was originated at Clemson Agricultural College and is described in the Journal of Economic Entomology and Circular 262, Clemson Agricultural College (see reference list). Some modifications in the method as originally described have been made and the information presented below represents the best judgment of the authors as to the procedure to be followed in this region.

This is the slowest of the sap-stream methods. Its principal advantage lies in the fact that it requires no equipment except a barrel or other container in which the posts may be stood on end.

The principles underlying the treatment appear to be as follows: When a freshly-cut unbarked stick is stood upright in a container of liquid, moisture is evaporated from the exposed cut end. This creates a vacuum and pulls the treating solution into the immersed end of the stick. There seems to be a very definite limit to the amount of liquid that can be taken up within a reasonable time. This amount is rather small and does not appear to be related to the strength of solution or to the depth of liquid in the container. Therefore, in order for the post to take up enough solution to provide for one pound of dry zinc chloride or 13 ounces of dry chromated-zinc chloride per cubic foot of wood, *it is necessary to use concentrated solutions.*

Preservative solution will rise in the butt end of the post to the height of only about a foot and special handling is needed, subsequent to removal from the container, to cause the preservative to distribute itself through the post.

Movement of the preservative within the post after it is removed from the container is apparently affected to a considerable extent by gravity. If the posts are placed vertically *with the treated end down* there is little movement of the preservative. If, however, the posts are placed vertically *with the treated end up* the preservative becomes quite evenly distributed throughout the wood in two to three months. *This is very important.*

With these statements as a background, proceed as indicated below:

(Note—in the following instructions the term "butt end" is the end of the post which will ultimately be below ground irrespective of whether it is the large or small end.)

1. Pour about three inches of the solution to be used into the container and then place the posts vertically in the container *with the butt end down.* Notch a lath to show the depth of the liquid. Using Table 2, compute the total cubic volume of the posts in the charge. If the species to be treated is maple or birch, add two pounds of 50 per cent zinc chloride solution (or two

pounds of 40 per cent chromated-zinc chloride solution) per cubic foot of wood. If the species is pine, add four pounds of 25 per cent zinc chloride (or 4 pounds of 20 per cent chromated-zinc chloride) per cubic foot. When the depth of liquid has dropped to the notch, sufficient solution will have been taken up by the posts and they should be removed.

2. To insure a more positive treatment of the top end of the posts, stand them *with the top end down* in the treating solution for two hours after Step 1 above has been performed. Step 2 is considered to be well worth while even if it does necessitate an extra handling.

After treatment is completed, the posts should be placed in a vertical position *with the butt ends up* for two to three months to allow the preservative to become distributed throughout the wood.

Table 2. Volumes of Round Posts, Stakes, etc. in Cubic Feet.

Average diameter (inside bark) inches	Volume per linear foot cubic feet	Length in feet						
		5	6	7	8	9	10	12
		Volume in cubic feet						
0.5	.0014	.007	.008	.010	.011	.013	.014	.017
1.0	.0060	.030	.036	.042	.048	.054	.060	.072
1.5	.0120	.060	.072	.084	.096	.108	.120	.144
2.0	.0220	.110	.132	.154	.176	.198	.220	.264
2.5	.0340	.170	.204	.238	.272	.306	.340	.408
3.0	.0490	.245	.295	.345	.390	.440	.490	.588
3.5	.0670	.335	.400	.470	.535	.605	.670	.804
4.0	.0870	.435	.520	.610	.695	.780	.870	1.044
4.5	.1100	.550	.660	.770	.880	.990	1.100	1.320
5.0	.1360	.680	.815	.955	1.090	1.225	1.360	1.632
5.5	.1650	.825	.990	1.155	1.320	1.485	1.650	1.980
6.0	.1960	.980	1.175	1.370	1.565	1.765	1.960	2.352
6.5	.2300	1.150	1.380	1.610	1.840	2.070	2.300	2.760
7.0	.2670	1.335	1.600	1.870	2.135	2.400	2.670	3.204
7.5	.3070	1.535	1.840	2.145	2.450	2.760	3.070	3.684
8.0	.3490	1.745	2.090	2.440	2.790	3.140	3.490	4.189
8.5	.3940	1.970	2.360	2.755	3.150	3.545	3.940	4.728
9.0	.4420	2.210	2.650	3.090	3.535	3.980	4.420	5.304
9.5	.4920	2.460	2.950	3.440	3.930	4.425	4.920	5.904
10.0	.5450	2.725	3.270	3.815	4.360	4.905	5.450	6.540

Steeping or Cold Soaking

The Station has not investigated this method of treatment. The information herein contained was abstracted from Mimeographs R-621 and R-1445 of the U. S. Forest Products Laboratory (see reference list).

This method cannot be depended upon to insure as long serviceable life as others which force or transport the preservative more deeply into the wood. On the other hand, it is extremely easy to apply and the indications are that the results obtained will be commensurate with the costs incurred.

This method may be used to treat both posts and sawed lumber but stickers should be used to separate layers of sawed material. As indicated under the open-tank method, if both the heartwood and sapwood are exposed, most of the preservative will be absorbed by the latter. More uniform results will be obtained if only one kind of wood is included in a charge.

The equipment required consists of a tank of such dimension that the timbers may be completely immersed and a weighting or other device to keep them submerged. Somewhat better absorption and penetration will result if there is some "head" of liquid above the timbers. Better results will also be obtained if work is done in warm weather. *The wood must be thoroughly peeled.*

Two preservatives are recommended:

a. *Zinc chloride (or chromated-zinc chloride).* The wood *may be seasoned or unseasoned.* Any species may be treated but the pines appear to be more absorptive than most other species. Soaking should be continued for a week or more.

A 5 per cent solution strength is recommended and this should be maintained. Solution strength may be checked either by chemical analysis or by hydrometer readings. At 60° F. the specific gravity of 4 per cent zinc chloride is 1.037; of 5 per cent, 1.047, and 6 per cent, 1.056. Solutions which have been used for a number of successive charges of wood may dissolve certain extractives from the wood which will give false hydrometer readings. Solutions so used should be checked for zinc chloride (or chromated-zinc chloride) by chemical analysis.

Wood treated with zinc chloride or chromated-zinc chloride by this method should not be used in wet locations where leaching may be excessive.

b. *Pentachlorphenol. The wood must be thoroughly seasoned.* The species which have shown the best absorptions and penetrations by this method are oaks and pines.

Soaking should be continued for at least 48 hours but there appears to be little advantage in prolonging the process beyond one week.

A 5 per cent solution strength is recommended. Concentrated solutions are reduced to the required strength by adding kerosene, fuel oil or even old crank case oil, if it is not too dirty. Kerosene and fuel oil are solvents well known to everyone. Also available are a number of industrial solvents manufactured by the oil refineries. If one of these solvents is used, *the buyer should insist that the material conform to the specifications for Stoddard solvent* as outlined in U. S. Bureau of Standards Booklet CS3-28. This will insure him of a material that is safe to use.

It should be remembered, however, that any petroleum solvent such as kerosene, fuel oil, Stoddard solvent, or similar material is inflammable and should be kept away from fire of any kind.

The cleanness and paintableness of the treated wood will depend upon the color of the concentrate and solvent used. Dark colored concentrates and the lower priced petroleum solvents (fuel oil or used crank case oil) are more

readily visible in the wood and for many uses are quite satisfactory. However, if the surface is to be painted, a light colored concentrate and a more refined solvent such as kerosene or a light colored industrial solvent should be used.

Superficial Methods

Brushing, Spraying or Dipping for Short Periods

Coal tar creosote conforming to A. W. P. A. specifications for brush, spray or dip treatment is the preservative suggested. Better results will be obtained if it is heated to about 180° F., *but care should be taken to keep it away from an open flame.* Wood of any kind and of any form may be treated by this method. It should be thoroughly seasoned and free of surface moisture. All bark should be removed.

Preservative applied in this manner does not penetrate the wood to any extent and, consequently, the method is not suitable for posts or other timbers which are in constant contact with the soil. On the other hand, wood is used in many locations, especially around farm buildings, where conditions favoring decay are not severe. In such cases a superficial coating of creosote will often add years to the serviceable life. The cost of the treatment is very low. Dipping is better than spraying or brushing because the preservative is worked into checks and other openings.

Stakes which are removed annually may be dried out and retreated at two-year intervals. Minor wooden farm buildings and apparatus such as brooder houses, hog houses, poultry laying houses, feed troughs, racks, roosts and stable floors, which are subject to frequent cleaning and disinfection to keep them in sanitary condition, may be brushed or sprayed with creosote, used with the precautions noted on page 6. This is a good cheap disinfectant and, in addition, helps to preserve the wood.

MIXING SOLUTIONS

Some preservatives are purchasable in ready-to-use form. Frequently, however, an appreciable saving can be made in transportation charges by buying in concentrated form, either liquid or solid, and adding the proper solvent at the place of treatment. The solvent may be water or an organic solvent such as kerosene or fuel oil. The amount of solvent which must be added to a dry or liquid concentrate to obtain solutions of any desired strength is obtained from the formula given below. In applying the formula it is customary to ignore impurities in the concentrate.

$$P = \frac{a - b}{b}$$

In which:

P = number of pounds of solvent to be added to each pound of concentrate.
a = percentage strength of the concentrate, expressed as a whole number.
b = percentage strength of the treating solution, expressed as a whole number.

Two examples will serve to illustrate the application of the formula:

a. How many pounds of kerosene or fuel oil must be added to each pound of a solution of pentachlorphenol of 24 per cent strength to obtain a solution of 5 per cent strength?

$$P = \frac{a - b}{b} = \frac{24 - 5}{5} = \frac{19}{5} = 3.8 \text{ pounds of kerosene}$$

b. How many pounds (pints) of water must be added to each pound of dry granular zinc chloride (strength taken as 100 per cent) to obtain a solution of 7 per cent strength?

$$P = \frac{a - b}{b} = \frac{100 - 7}{7} = \frac{93}{7} = 13.3 \text{ pounds of water}$$

REFERENCE LIST

Obtainable by purchase or from reference libraries:

1. Wood Preservation by G. M. Hunt & G. A. Garratt, 1938, 450 pages, illus. McGraw-Hill Book Co.
2. A New Method of Impregnating Green Fence Posts: A Preliminary Report by W. C. Nettles, 1939, Jour. Econ. Entomology, Vol. 32, No. 5, Pages 703-4.

Obtainable by purchase from Supt. of Documents, Gov't. Printing Office, Washington, D. C.:

1. The Preservative Treatment of Farm Timbers by G. M. Hunt, 1928, 34 pages, illus. U. S. D. A. Farmers' Bulletin No. 744. Price 5 cents.
2. Chemical Impregnation of Trees and Poles for Wood Preservation by B. H. Wilford, 1944, 30 pages, illus. U. S. D. A. Circular No. 717. Price 10 cents.

Obtainable from U. S. Forest Products Laboratory, Madison 5, Wisconsin, without charge. Mimeographs number:

R-1158. The Tire Tube Method of Fence Post Treatment by R. M. Wirka, 1941, Revised.

R-1284. Preservatives, Priorities and Processes by G. M. Hunt, R. H. Baechler and J. A. Blew, 1942.

R-621. Preservation of Timber by the Steeping Process by R. M. Wirka, 1939.

R-1445. Treating Wood in Pentachlorphenol Solutions by the Cold Soaking Method by J. A. Blew, 1944.

Obtainable from Clemson Agricultural College, Clemson, South Carolina, without charge:

1. Longer Life for Fence Posts by W. C. Nettles, 1944. Circular 262, Clemson Agricultural College.

SOURCES OF PRESERVATIVES

The following firms are listed as manufacturers or distributors of the preservatives mentioned in this report. This list is incomplete. It should not be taken as an endorsement by the Station of the products of these manufacturers or distributors or as discrimination against firms dealing in products conforming to the same specifications.

COAL TAR CREOSOTE

Apothecaries Hall Co., Waterbury, Conn.
Cadwell & Jones, 1084-1086 Main St., Hartford, Conn.
Dwight R. Judson Co., 462-466 Main St., Hartford, Conn.
Eastern States Farmer's Exchange, West Springfield, Mass.
Koppers Co., Tar & Chemical Division, New Haven, Conn.
Rogers & Hubbard Co., Middletown, Conn.

PENTACHLORPHENOL

Apothecaries Hall Co., Waterbury, Conn.
A. D. Chapman & Co., Inc., 333 No. Michigan Ave., Chicago, Ill.
Dow Chemical Co., Midland, Mich.
Dwight R. Judson Co., 462-466 Main St., Hartford, Conn.
Monsanto Chemical Co., RCA Bldg., New York City.
Monsanto Chemical Co., St. Louis, Mo.
Rogers & Hubbard Co., Middletown, Conn.

ZINC CHLORIDE AND/OR CHROMATED-ZINC CHLORIDE

American Agricultural Chemical Co., New York City.
Apothecaries Hall Co., Waterbury, Conn.
du Pont de Nemours Co. (Grasselli Chemicals Dept.), New Haven, Conn.
Dwight R. Judson Co., 462-466 Main St., Hartford, Conn.
Rogers & Hubbard Co., Middletown, Conn.

STODDARD SOLVENT

American Oil & Supply Co., Newark, N. J.
Socony-Vacuum Co., Inc., New Haven, Conn.